

REMARKS

The Office Action mailed March 13, 2007 has been reviewed and the comments of the Patent and Trademark Office have been considered. Claims 1-8, 10, 11, and 13-17 are pending in the application. Claims 1-5, 7, 11, 13, 16 and 17 have been amended, and claims 9 and 12 have been cancelled. A detailed listing of all claims that are, or were, in the application, irrespective of whether the claim(s) remain under examination in the application, are presented, with an appropriate defined status identifier.

Claim Rejections

Claims 1-8, 10, 11, and 13-17 are rejected under 35 U.S.C. § 112, second paragraph as being indefinite.

Claim 1 is rejected because of issues with antecedent basis and awkward language. Claim 1 has been amended to address this issue. Thus, reconsideration and withdrawal of this objection is respectfully requested.

Claim 2 is rejected because it allegedly fails to further claim the invention. This rejection is respectfully traversed. Claim 1 asserts that “an alloy of the second metal material and Al starts to be formed at a temperature equal or greater than the melting point of Al”. Claim 2 clearly further limits this by asserting that the alloy “starts to be formed at a temperature equal or greater than the heat treatment temperature”. The melting point of Al, and the heat treatment temperature are two distinct and separate temperatures. Thus, it would not be correct to assert that starting to form an alloy at a temperature equal or greater than that of Al is equivalent to starting to form an alloy at a temperature equal or greater than that of the heat treatment temperature, as per the invention as claimed. The claim has been amended to further clarify this distinction. Thus, reconsideration and withdrawal of this rejection is respectfully requested.

Claim 7 is rejected because it erroneously depends from the wrong claim. Claim 7 has been amended to address this issue. Thus, reconsideration and withdrawal of this objection is respectfully requested.

Claim 16 is rejected because of unclear language. Claim 16 has been amended to address this issue. Thus, reconsideration and withdrawal of this objection is respectfully requested.

Claim 17 is rejected for the same reasons as claim 2. The arguments made regarding claim 2 are equally applicable here, and thus reconsideration and withdrawal of this rejection is respectfully requested.

As an aside, claims 2-4 and 17 were amended to correct a typographical error observed by Applicant.

Prior Art Rejections

In the Office Action, claims 1-8, 10, 11, and 13-17 are rejected under 35 U.S.C. § 102(b) as being anticipated by, or in the alternative, under 35 U.S.C. § 103(a) as being obvious over JP 2000-164928 (hereinafter “JP 928”). Claims 5, 11 and 14 are rejected under 35 U.S.C. § 103(a) as being unpatentable over JP 928 in view of Gandhi (“VLSI Fabrication Principles”). Applicant respectfully traverses this rejection for at least the following reasons.

Claims 1-8, 10, 11, and 13-17 are rejected under 35 U.S.C. § 102(b) as being anticipated by, or in the alternative, under 35 U.S.C. § 103(a) as being obvious over JP 928. It is respectfully submitted that JP 928 does not teach all of the features of the independent claims, nor does it lend itself to combination to teach the features of the independent claims.

Specifically, JP 928 teaches an n-side electrode formed on an n-conductive layer made of an n-type Group III nitride based semiconductor, with an electrode that comprises a contact layer made of Hf, Al or Ti being formed in contact with the n-conductive layer. The electrode also comprises a barrier layer made of W being formed on the contact layer, and a bonding pad layer made of Au being formed on the barrier layer. JP 928 teaches a typical example of the n-side electrode as shown in Fig. 1, where the n-side electrode has such a multi-layered structure comprising an Hf layer 14, and Al layer 15, and Hf layer 16, and Au layer 17, and Ti layer 18, a W layer 19, and an Au layer, in which the three layer structure composed of the Hf layer 14, the Al layer 15 and the Hf layer 16 corresponds to the contact layer.

Accordingly, JP 928 teaches such an n-side contact electrode layer that is composed of a plurality of thin films, each of which is made of Hf, Al or Ti, as illustrated in Fig. 1. In addition, JP 928 also teaches a modification such that the n-side electrode may comprise a contact layer made of Hf, Al, Ti or a metal alloy therebetween being formed in contact with the n-conductive layer, a barrier layer made of W formed on the contact layer, and a bonding pad layer of Au formed on the barrier layer (paragraph 81 of JP 928).

JP 928 only teaches a structure such that a contact layer has a thin film made of Hf, Al, Ti, or a metal alloy therebetween to be in contact with the n-conductive layer, and a barrier layer made of W formed on the contact layer. However, JP 928 fails to teach a structure such that: the intermediate metal layer comprising a metal material having a melting point greater than the melting point of Al is in contact with the n-conductive layer, wherein the first metal layer made of the first metal material being comprised of Al, is formed on the intermediate metal layer; and the second metal layer formed on the first metal layer is made of the second metal material comprising at least one metal selected from the group consisting of Nb, Fe, Re, Ta and Zr, in place of layer made of W.

JP 928 fails at least to suggest such a replacement of W with a metal material comprising at least one metal selected from the group consisting of Nb, Fe, Re, Ta and Zr for the barrier layer employed in the n-side electrode. In other words, JP 928 by no means suggests that such metal material comprising at least one metal selected from the group consisting of Nb, Fe, Re, Ta and Zr may be successfully used, instead of W, to form the barrier layer preventing the diffusion of Au into the n-conductive contact layer made of a Group III nitride semiconductor.

In view of these features, the electrode as currently claimed in amended Claim 1 and the method for manufacturing that electrode as claimed in amended Claim 16 is significantly different from the n-side electrode of JP 928, and such distinctive features are never obvious over JP 928. If this rejection is maintained, the examiner is respectfully requested to point out where these features are disclosed in JP 928.

The dependent claims are also patentable for at least the same reasons as the independent claims on which they ultimately depend. In addition, they recite additional patentable features when considered as a whole. As mentioned above, Applicant believes that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.

Claims 5, 11 and 14 are rejected under 35 U.S.C. § 103(a) as being unpatentable over JP 928 in view of Gandhi. Gandhi does not make up for the deficiencies of JP 928. Gandhi teaches refractory metals which are potentially useful in self-aligned masking technology used for the fabrication process of VLSI formed on Si or GaAs substrates, as listed in Table 2.

Hence, Gandhi teaches only the use of refractory metals listed in Table 8.2 in self-aligned masking technology for fabrication of Si or GaAs VLSI devices, in particular for the formation process of gate electrodes of Si or GaAs FETs. For instance, the layer of refractory metals formed on the polysilicon layer is used as a masking layer for selective etching of the polysilicon layer in self-aligned masking technology for an Si MOS FET with a polysilicon gate.

However, Gandhi fails to teach anything about the usefulness of the refractory metal in question to the formation process of an n-side electrode on the n-conductive contact layer made of a Group III nitride semiconductor.

First, Gandhi fails to give any reasonable suggestion that each of Co, Cr, Mo, Ni Nb, Pd, Pt, Ta, W, V, or Zr may be suitably employed as a contact layer, in place of Hf, or Ti, to form the n-contact electrode on the n-conductive contact layer made of Group III nitride semiconductor.

Second, Gandhi fails to give any reasonable suggestion that each of Co, Cr, Hf, Mo, Ni, Nb, Pd, Pt, Ta, V, or Zr may be suitably employed as a barrier layer, in place of W, to form the n-side electrode on the n-conductive contact layer made of Group III nitride semiconductor.

Therefore, there is no reason to believe that each of Co, Cr, Mo, Ni, Nb, Pd, Pt, Ta, W, V, or Zr may be suitably employed as a contact layer, in place of Hf or Ti, to form the n-contact electrode on the n-conductive contact layer made of Group III nitride semiconductor, or that each of Co, Cr, Hf, Mo, Ni, Nb, Pd, Pt, Ta, Ti, V or Zr may be suitably employed as a barrier layer, in place of W, to form the n-side electrode on the n-conductive contact layer made of Group III nitride semiconductor.

Indeed, if Hf or Ti were suitably employed as a barrier layer to form the n-side electrode on the n-conductive contact layer made of Group III nitride semiconductor, JP 928 would not use a further layer made of W as a barrier layer for the n-side electrode. Furthermore, if Ni were suitably employed as a barrier layer to form the p-side electrode on the p-conductive contact layer made of Group III nitride semiconductor, JP 928 would no further use a layer made of W as a barrier layer for the p-side electrode.

Accordingly, JP 928 strongly suggests that there is no reason to believe that as each of Co, Cr, Hf, Mo, Ni, Nb, Pd, Pt, Ta, Ti, W, V, or Zr are refractory metals being potentially useful in self-aligned masking technology, each of Co, Cr, Hf, Mo, Ni, Nb, Pd, Pt, Ta, Ti, V or Zr would be also suitably employed as a barrier layer, in place of W, to form the n-side electrode on the n-conductive contact layer made of Group III nitride semiconductor.

As explained above, the rejection based on the combination of JP 928 with Gandhi is by no means reasonable. If this rejection is maintained, the examiner is respectfully requested to point out where these features are disclosed in JP 928 and Gandhi.

Conclusion

In view of the foregoing amendments and remarks, Applicant believes that the application is now in condition for allowance. An indication of the same is respectfully requested. If there are any questions regarding the application, the examiner is invited to contact the undersigned attorney at the local telephone number below.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a

check or credit card payment form being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. § 1.136 and authorizes payment of any such extensions fees to Deposit Account No. 19-0741.

Respectfully submitted,

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